AP® BIOLOGY
2005 SCORING GUIDELINES

Question 4

NOTE: One point is awarded for each bulleted item; maximum of 4 points for each section.

Provides an immediate nonspecific immune response (4 points maximum)

- Physical barrier (e.g., skin or mucous membranes [or blood clot]) with explanation that barrier prevents pathogens and parasites from entering the body. Resident microflora prevents pathogen attachment. Saliva, mucous, or tears wash away harmful entities; also vomiting/diarrhea purge harmful agents.
- Chemical barriers (low pH, salt, fatty acids of skin inhibit microbial growth, antimicrobial agents [e.g., lysozyme kills bacteria by digesting bacterial wall]).
- Inflammatory response: blood vessels dilate (precapillary arterioles dilate and postcapillary venules constrict), producing redness, edema, heat (fever), pain, and leading to an increase in white blood cells and clotting factors.
- Chemical agents:
    i. Interferons from cells infected with viruses stimulate nearby cells to produce chemicals that inhibit viral reproduction, OR chemokines activate monocytes to develop into macrophages.
    ii. Histamines cause increase in permeability of capillaries with an increased blood flow that results in more clotting and more white blood cells, OR histamines secreted by mast cells, OR prostaglandins increase blood flow.
    iii. Pyrogens induce fever that inhibits pathogen.
- Phagocytosis: ingestion by white blood cells (e.g., neutrophils, macrophages, or monocytes)
- Lysis of cells: Eosinophils or natural killer cells
- Complement system: leads to the lysis of microbes, or aids in recruitment of white blood cells.
- Elaboration of any one of the above (e.g., a second physical or chemical barrier)

Activates T and B cells in response to an infection (primary immune response)
(4 points maximum)

- Macrophages/white blood cells engulf and/or display antigens (may say: epitope) from infection.
- Antigen-presenting cell binds helper T cells to activate or stimulate helper T cells.
- Antigen-presenting cell activates or stimulates cytotoxic T cells.
- Antigen binding to B cell activates B cell.
- Helper T cell activates/stimulates B cell and/or cytotoxic T cell.
- Interleukin—1 (from macrophages) activates helper T cells.
- Interleukin—2 and/or cytokines (from helper T cells) activate B cells or cytotoxic T cells.
- CD4 on helper T cell enhances binding of helper T with antigen-presenting cell; leads to activated T cells.
- CD8 on cytotoxic T cell enhances binding and enhances activation of cytotoxic T cell.
- Elaboration point for explaining one of the following:
    i. MHC in primary immune response.
    ii. B (or plasma) cells produce/secrete antibody.
    iii. Cytotoxic T cells destroy infected cells.
    iv. Antibody mechanism of action (i.e., neutralization/agglutination/precipitation).

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Question 4 (continued)

Responds to a later exposure to the same infectious agent (secondary immune response) (4 points maximum)

- Mediated by memory cells (T and/or B).
- Memory cells are specific for the same antigen encountered previously.
- Memory cells receptors/antibodies have greater affinity for the antigen.
- Production of antibodies/response is faster and/or to a greater extent.
- Origin of memory cells:
  - i. Helper T cell → Memory Helper T → Memory B and T cells
  - ii. Activated B cell → Memory B cell
  - iii. Activated Cytotoxic T cell → Memory T cell
- Role of major histocompatibility complex (MHC), cytokines, IL-1, or IL-2 as related to secondary immune response.
- Memory cells are more numerous (or antibody concentration is higher).
- Memory cells are long-lived.
- Elaboration of why measles, mumps, chicken pox do not recur (vaccines), or common cold/flu do recur.

Distinguishes self from nonself (4 points maximum)

- All cells have unique ID tags (flags, markers, proteins, glycoproteins, MHC, etc.).
- Origin of "self" markers of MHC by multiple alleles (polymorphic antigen receptors).
- Developmental selection in bone marrow and/or thymus where antigen receptors are tested (self-antigen receptors are eliminated, or inactivated/clonal selection).
- Mechanism of recognition (binding elicits immune response).
- Illustrate self/nonself incompatibilities: (e.g., autoimmune disease such as MS, transplant incompatibility; blood types, and pathogens mimicking MHC molecules, or cloaking with host cell membrane).
- Elaboration of:
  - i. MHC (or human leukocyte antigens)
  - ii. Distinguish between MHC I and II
    (e.g., MHC I—all nucleated cells; MHC II—dendritic cells, macrophages, B cells).

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